NAVAL HEALTH RESEARCH CENTER

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ABSTRACT

Purpose: The purpose of this prospective study was to examine the effectiveness of self-assessed fitness and exercise in predicting objectively measured physical fitness.

Methods: Study subjects included 1583 men who entered Marine Corps training in San Diego, California, between September and November 2002 and completed a questionnaire and an objective fitness test. The questionnaire included demographic and self-assessed fitness/exercise items and was administered immediately upon entry into the training program. The objective fitness measure was obtained using a standardized test after approximately 1 month of training.

Results: Multivariate modeling found that several measures of self-assessed fitness and exercise (estimated number of pull-ups; good, very good, or excellent self-assessed fitness; sweating quite a lot or most or all of the time during physical activity; and competitive experience) were all associated with the objective fitness score. These results remained statistically significant after controlling for age, race, and body mass index (model adjusted $R^2 = 0.469$).

Conclusion: In this analysis, self-assessed fitness and exercise parameters that can be easily ascertained with a short questionnaire predicted objective fitness scores approximately 1 month later. This information could be used by recruiters to make recommendations for pre-enlistment conditioning.

Various branches of the military have reported low levels of fitness within incoming recruit populations who are expected to begin a rigorous training regimen immediately after arrival at boot camp (4). The inability to pass basic military physical fitness tests because of low fitness levels may lead to injury and contribute to overall attrition in the armed forces (7). This is a particular problem among Marine Corps recruits. Previously identified risk factors for military attrition include lack of previous exercise, low levels of fitness, previous injury, lack of participation in previous exercise of sufficient intensity, higher body mass index (BMI), and other lifestyle factors (4-6, 12). However, many of these potential risk factors are difficult to identify prior to training and some are not able to be modified during a training program. Low fitness is an important predictor of military success at the training level, and understanding how to evaluate this parameter prior to entry may be useful in assuring that incoming recruits have the best chance of success.

Among the ways to identify low entry fitness is to objectively assess fitness at entry. However, at this point the recruit is already at the site and beginning to train. A simple pen-and-paper test that could flag persons who may not be successful after the first month of training would save much time and effort. One way to do this is to identify self-assessed fitness and exercise parameters that are associated with objective fitness. Previous studies have shown that self-assessed fitness levels have been used with varying levels of success in other settings (1, 6,13). The goal of the present study was to determine the usefulness of self-assessed fitness and exercise parameters in predicting objectively measured physical fitness in U.S. Marine Corps recruits.

Methods

Subjects

The study population consisted of male Marine Corps recruits entering the Marine Corps Recruit Depot (MCRD), San Diego, California, between September 19 and November 4, 2002. Recruits were asked to complete a questionnaire administered within 3 days of their arrival at MCRD. After approximately 1 month all recruits participated in a physical fitness test (PFT-1). The final study population consisted of the 1583 recruits who completed a questionnaire and participated in the PFT-1. The study protocol was reviewed and approved by the Institutional Review Board of the Naval Health Research Center, and participants read and signed informed consent documents before completing the questionnaire. This research has been conducted in compliance with all applicable federal regulations governing the protection of human subjects in research.

Our sample size calculations used a difference of 13.8 points as our effect size of interest (11). Assuming an alpha level of 0.05 and 80% power, 1530 subjects would be required. A total of 2040 recruits were surveyed to allow for the high dropout rate during the first few weeks of boot camp (about 22.4% in this case), leaving a final sample size of 1583.

Fitness Scores

Objective fitness, the major outcome variable, was measured by the PFT-1 score. This test consists of abdominal crunches, pull-ups, and a 3-mile run and is scored as follows: number of abdominal crunches completed in 2 min (1 point each) to a maximum of 100 points, plus number of pull-ups (5 points each for a maximum of 20 pull-ups) to a maximum of 100 points, plus a sliding scale of points associated with time on a 3-mile (4.8-km) run in 18:00 min or less

worth 100 points. The maximum PFT-1 score is 300 points; to pass the fitness test, the recruit must meet a minimum standard for each component and earn a total score of at least 135 points.

Questionnaire

Items on the questionnaire included age, race/ethnicity, general demographics, self-assessed fitness (excellent, very good, good, fair, or poor), and physical activity habits prior to boot camp such as amount of competitive activity, frequency of sweating during physical activity (indicative of exercise intensity), and predicted number of pull-ups (see Appendix). The subjects filled out the questionnaire during their routine physical exams at the on-base MCRD Branch Medical Clinic. Project staff explained the consent form and answered any questions the recruits had prior to administration of the items. Official Marine Corps personnel not associated with the study left the area during the administration of the survey to ensure confidentiality. Each item was read aloud to the recruits, and study personnel circulated around the group to answer any questions that the subjects might have about the items or procedure. The Marine Corps administrative records provided additional demographic information, including height (in inches) and weight (in pounds) measured at the medical clinic the first week of arrival at camp. These values were converted to meters and kilograms, respectively, and BMI was calculated as (kg/m^2).

For analysis, four exposure variables were created: predicted number of pull-ups (used as a continuous variable), self-assessed fitness (dichotomized as “poor/fair” vs. “good/very good/excellent”), competition (dichotomized as “no exercise / no competitive exercise” vs. “competitive exercise”), and sweat frequency (dichotomized as “never/occasionally/fairly often” vs. “quite a lot/most or all the time”). Age and BMI were used as continuous variables and race/ethnicity was dichotomized as white versus other.

Statistical Analysis

All data were double entered and validated visually by the principal investigator. All analyses were performed using Epi Info 2000 (Centers for Disease Control and Prevention, Atlanta, GA), SAS Version 8 (SAS Institute, Inc., Cary, NC), and SPSS Version 9 (SPSS, Inc., Chicago, IL) programming packages. Descriptive analyses included frequencies and distributions of demographic and questionnaire variables. In addition, questionnaire items and demographic variables were compared using a chi-square test for categorical variables and a *t*-test for comparing means for study participants and the 454 recruits who did not complete their required fitness test because of illness or attrition.

Univariate analyses were performed to determine potential associations between questionnaire items (exposure variables) and PFT-1 score (outcome variable). Linear regression analysis was used to determine the strength of association between the score on the PFT-1 and potentially associated variables, controlling for age, BMI, and race/ethnicity. Statistical significance levels were based on a two-tailed *p*-value less than 0.05.

Results

Of the original 2040 recruits, 3 men declined to fill out the questionnaire and 454 men who filled out the questionnaire were dropped from the study because they did not take the PFT-1. Of the 454 men with missing fitness data, 331 did not take the PFT-1 because of illness or injury at the time of the test and 123 men left the military sometime during the first 4 weeks for various reasons. The 454 recruits who completed questionnaires but were missing fitness scores differed from study subjects only on whether they participated in competitive activity (62% of the study subjects participated in competitive activity vs. only 58% of men who were missing PFT-1 scores, $p < 0.05$).

The mean PFT-1 score for the study recruits was 226.8 (range 72–300). The average age of the 1583 recruits in this study was 19.2 $\pm$ 1.9 years (range of 17–32 years). Univariate comparisons showed no association between age and PFT-1 scores. The average BMI was 23.9 $\pm$ 3.4 and was inversely associated with PFT-1 scores. The population was predominantly white (63%), followed by Hispanic (25%), and African American (4%); about 8% were classified as “other or decline to state.” There were statistically significant differences in PFT-1 scores among the race/ethnicity groups, with the African American group having the highest score (239) and the white group having the lowest score (225). When used as a dichotomized variable, the white group had lower PFT-1 scores than the combined group (225 vs. 229; $p < 0.01$) (Table 1).

Table 2 shows several self-assessed fitness and exercise parameters that were statistically significantly associated with PFT-1 scores. The mean number of predicted pull-ups was 10 and was associated with PFT-1 scores ($p < 0.01$). Predicted and actual number of pull-ups were correlated ($r = 0.723$; $p < 0.01$). Univariate associations indicated that self-assessed fitness, competitiveness, and frequency of sweating during exercise were all positively associated with PFT-1 scores (Table 2).

In the multivariate linear regression analysis, self-assessed fitness and exercise parameters remained statistically significant predictors of objective fitness (PFT-1) even after controlling for each other and age, BMI, and race/ethnicity (Table 3). Overall, the model explained 47% of the variance. Although all variables in the final model were statistically significant at $P < 0.01$, predicted number of pull-ups was the strongest variable, with a standardized beta of 0.62.

Discussion

This study identified self-assessed fitness and exercise parameters that were associated with objectively measured fitness. Subjects were asked to rate themselves in terms of physical fitness, competitiveness, and exertion level (sweat frequency) and to estimate how many pull-ups they could currently do, all of which were significantly associated with PFT-1 score. Previous research demonstrates that individuals who are reasonably active can accurately assess their fitness and exercise intensity levels (6,13), and that seemed to hold true for the subjects included in this study.

The fact that recruits who believed before boot camp that they could do more pull-ups were more successful on the PFT-1 suggests that strength training might be beneficial for incoming recruits. This finding also corroborates previous research indicating that upper body strength measures were more closely related with self-assessments than measures of lower body strength (8). Although often overlooked, strength and resistance training should be an important component of an overall fitness-training program because of the documented benefits on a variety of health and performance parameters. According to a recent review, strength training has been shown to reduce body fat, increase basal metabolic rate, decrease blood pressure and the cardiovascular demands of exercise, and improve blood metabolic profiles. Furthermore, observed increases in muscle strength have been shown to be associated with many improvements in physical function and performance (8).

Questionnaires in general have proved very useful for physical activity assessment in a variety of populations (5,12). Questionnaires are useful because they are non-reactive, practical, can be made applicable to specific populations, and have been shown to be reasonably accurate. Indeed, the predictive strength of the direct self-assessment questions in regards to the recruits’

current fitness status and exercise parameters may be more accurate than variables for which recruits need to recall actual exercise habits. Remembering details of prior participation in physical activity may be very difficult and requires great effort on the part of the respondent (4). Other studies have suggested that self-assessment may be biased according to social desirability of the behavior (3), although that does not seem to be operating here given the high correlation between predicted and actual pull-ups ($r = 0.72$).

In the current study, categorical variables were dichotomized for use in a linear regression model, as the original categories did not meet the criteria for inclusion in a linear regression model. This dichotomization method has been used in other studies of health and fitness, and the dichotomized variables behaved very similarly to the original categorical variables from which they were derived in regard to size and significance of association (9).

These data could be useful to military personnel by identifying those individuals at risk for low fitness, and tailoring physical training prior to the PFT-1 to improve their scores. The questionnaire items identified can also be used to fine-tune pre-enlistment evaluation of incoming recruits.

The purpose of this research was to understand whether there was any predictive value in the questions about self-assessed fitness and exercise before the recruits had any objective data regarding their ability. Also, many men drop out during the first few weeks of boot camp, and our concern was to look at fitness predictors for those who made it through that critical time. Those who do not make it to the PFT-1 mainly consist of men who are injured/ill, or who have left the Corps for a number of reasons.

The specific limitations of using a military population involve generalizability issues since military volunteers might differ from other people in the same age range. Also, use of

volunteers (in this case, individuals who volunteered to be Marines) raises the problem of selection bias within any population. Even within branches of the U.S. armed forces there are differences in health indicators. For example, Marine Corps men and women exhibit a lower prevalence of overweight than their Navy counterparts (2). However, these results may be very relevant to Marine recruits and are representative of the population that entered during the study recruitment period (only three men who were selected did not complete the questionnaire).

The benefits of using a military population include the excellent quality of military health databases and performance records. The standardized fitness testing conducted regularly during Marine Corps training provided a strong measure of objective fitness for this study. The relatively homogeneous nature of the recruits enabled the men to be queried under standard conditions at the same point in their training program. For these reasons, it is appropriate and convenient to utilize military data to determine the usefulness of self-assessed fitness data as long as the limitations of using military populations for this type of research are also recognized.

Conclusions

The present study demonstrates that self-assessed fitness and exercise parameters can predict objective physical fitness 1 month later. These measures are easily ascertainable by questionnaire. Including these types of questions when assessing beginning exercisers or those increasing the frequency, intensity, and time of their physical exercise (such as those beginning a military training program) might improve exercise prescription, which in turn might help prevent overuse injuries. Injuries resulting from inappropriate training levels are so common that preventive strategies and activities are justified on medical as well as economic grounds (10). Convenient, noninvasive methods for identification of lifestyle factors that predict low fitness

levels or slower fitness progress could enable recruiters to make recommendations for fitness preparation to incoming recruits.

Author Note

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TABLE 1. Distribution of demographic variables and unadjusted associations with PFT-1 score among 1583 male Marine Corps recruits, San Diego, CA, 2002.

Variables	Mean (SD)	Beta coefficient (SE)	*P*-value[a]
Age (years)	19.2 (1.9)	-0.56 (0.48)	0.25
BMI (kg/m^2)	23.9 (3.4)	-2.80 (0.21)	**<0.01**
	Recruits % (*n*)	PFT-1 score mean (SD)	P-value
Race/Ethnicity			**0.012**
White	62.9 (995)	225.4 (36.0)	
Hispanic	25.3 (401)	226.7 (36.9)	
African American	4.0 (64)	238.2 (33.9)	
Other/decline to state	7.8 (123)	232.6 (38.0)	
Race/Ethnicity (dichotomized)			**<0.01**
White	62.9 (995)	225.4 (36.00)	
Other	37.1 (588)	229.2 (37.02)	

[a]Partial F-test. PFT-1 = physical fitness test; SD = standard deviation; SE = standard error; BMI = body mass index.

TABLE 2. Distribution of self-assessed fitness and exercise parameters and unadjusted associations with PFT-1 score among 1583 male Marine Corps recruits, San Diego, CA, 2002.

Variable	Mean (SD)	Beta coefficient (SE)	*P*-value[a]
Pull-ups (predicted number)	10.4 (5.3)	4.65 (0.13)	**<0.01**
	Recruits % (*n*)	PFT-1 score mean (SD)	*P*-value*
Self-assessed fitness			**<0.01**
Poor	0.8 (13)	192.7 (37.2)	
Fair	20.5 (324)	210.1 (35.8)	
Good	53.8 (852)	225.3 (35.8)	
Very good	21.1 (334)	242.2 (29.3)	
Excellent	3.8 (60)	259.4 (27.5)	
Self-assessed fitness (dichotomized)			**<0.01**
Poor/fair	21.3 (337)	209.5 (35.9)	
Good/very good/excellent	78.7 (1246)	231.5 (35.1)	
Competition[b]			**<0.01**
No exercise at all	1.2 (19)	212.3 (21.9)	
No	36.4 (574)	220.2 (36.3)	
Yes	62.4 (986)	230.9 (36.1)	
Competition (dichotomized):			**<0.01**
No	37.6 (593)	219.9 (35.9)	
Yes	62.4 (986)	230.9 (36.1)	
Sweat frequency			**<0.01**
Never	0.3 (5)	241.2 (31.7)	

Occasionally	18.8 (297)	217.6 (36.1)	
Fairly often	38.8 (614)	224.2 (36.1)	
Quite a lot	27.9 (442)	230.9 (36.9)	
Most or all the time	14.2 (225)	237.7 (32.9)	
Sweat frequency (dichotomized)			**<0.01**
Never/occasionally/fairly often	57.9 (916)	222.2 (36.2)	
Quite a lot/most or all the time	42.1 (667)	233.2 (35.7)	

[a]Partial F-test

[b]Four recruits did not respond to this question, *n* = 1579.

PFT-1 = physical fitness test; SD = standard deviation; SE = standard error.

TABLE 3. Linear regression model for self-assessed fitness and exercise parameters and PFT-1 score,[a] 1583 male Marine Corps recruits, San Diego, CA, 2002.

Variable	Beta coefficient	SE	Standardized beta	*P*-value[b]
Self-reported parameters:				
Predicted number of pull-ups	**4.27**	**0.14**	**0.62**	**<0.01**
Self-assessed fitness: (low vs. high)	**5.40**	**1.74**	**0.06**	**<0.01**
Competition: (no vs. yes)	**2.82**	**1.43**	**0.04**	**0.04**
Sweat frequency (low vs. high)	**3.32**	**1.43**	**0.05**	**0.02**
Potential confounders:				
Age	0.09	0.36	0.01	0.26
Body Mass Index (BMI)	**-1.05**	**0.22**	**-0.09**	**<0.01**
Race/Ethnicity (white vs. other)	**7.78**	**1.40**	**0.10**	**<0.01**

[a]Adjusted for all variables in the model plus age, BMI, and race/ethnicity.

[b]Two-sided, for linear regression model p <0.01, statistically significant results in bold type, R^2 = 0.471, adjusted R^2 = 0.469.

PFT-1 = physical fitness test; SE = standard error; BMI = body mass index.

Appendix. Questions used to measure self-assessed fitness and exercise.

How many pull-ups can you do right now? __________

How would you rate your current physical fitness compared with others your age? (circle one answer)

1 – Poor
2 – Fair
3 – Good
4 – Very good
5 – Excellent

Is your exercise activity oriented toward competition (for example, marathons, triathlons, power lifting, body building)?

0 – Does not apply. I do not exercise.
1 – No
2 – Yes

In your exercise or leisure activities how often do you "work up a good sweat"? (circle one answer)

0 – Never
1 – Occasionally
2 – Fairly often
3 – Quite a lot
4 – Most or All the time

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14. ABSTRACT (maximum 200 words)
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